



WORKING YOUR WAY THROUGH THE MANUAL WHEELCHAIR CONFIGURATION PUZZLE

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“It is really hard to move this wheelchair,” she said.

“It looks like you are sitting on that chair, not in it. You can barely reach the rear wheels to get a decent push,” I told her.

“It’s because I have short arms, but I was told you guys could help,” she replied.

This straightforward, matter-of-fact response gave me the immediate sense that I had just met a person who was both self-aware and pragmatic. Leah was only in her third week of inpatient physical therapy, but she was ready to take charge of her rehabilitation journey. She had been referred to the wheelchair and seating clinic to be evaluated for a definitive manual wheelchair. However, the first order of business in my mind was to improve the setup of the chair she was using during her acute rehab stay. It was an ultralightweight, rigid manual wheelchair that was quite obviously not configured or adjusted optimally for her needs. Hospital-issued chairs are not custom-configured for the individual, so they are rarely ideal, but this one clearly hindered her abilities.

When we met, Leah was 27 years old with a diagnosis of incomplete paraplegia following a motor vehicle collision. Additionally, she had sustained L1-3 transverse process fractures, a left clavicle fracture and a renal contusion. At admission, her AIS (abbreviated injury scale) score was T12 AIS B (sensory incomplete), but she had started to gain strength below the level of her injury. Her AIS score now was T12 AIS C (motor incomplete, with less than half the muscle groups below the neurologic level strong enough to move against gravity).

Prior to her injury, she had no past medical history significant for mobility limitations. She lived in a small rural town with her significant other and two dogs. Her home was a ranch-style house with two steps to enter. She was self-employed as a hairstylist who owned her own salon. In addition, she worked part time as a bartender. Her plan at discharge was to return home, with a long-term goal to return to employment as a hairstylist. During her rehab stay, her significant other oversaw modifications to the home

for a ramp entry and to widen any doors necessary to permit entry to all rooms of the home.

At the time of her wheelchair evaluation, Leah reported low back pain and buttock pain of a burning nature that limited her wheelchair sitting tolerance. She also had lower extremity spasticity that manifested predominantly in an extension pattern.

This spasticity often interfered with her ability to perform transfers without assistance. She was independent with wheelchair parts management and level surface wheelchair mobility for household distances. Unfortunately, the poor setup of her hospital-issued wheelchair had limited her long-distance indoor propulsion, participation in outdoor mobility and training with higher-level wheelchair skills. She could perform up to a two-inch unlevel transfer with minimal assistance using a transfer board but reported difficulty transferring on and off the air cell seat cushion.

Leah was independent with weight shifts, oral facial hygiene and dressing and required partial assistance for toileting and bathing. Physical assessment revealed no significant postural asymmetries except for a flexible but slightly exaggerated lumbar lordosis and anterior pelvic tilt. Anatomic measurements also confirmed that she indeed had a long torso in relation to the length of her upper extremities.

A review of the configuration and setup of her hospital-issued wheelchair revealed 24-inch rear wheels with a center of gravity preset of .5 inches, an 18-inch rear seat height and a 19-inch front seat height. This setup resulted in a finished rear seat height of 18.5 inches on a high-profile air cushion. With this setup, Leah had poor access to the rear wheels. Instead of



FIGURE A Optimal elbow angle range

the recommended 100 to 120 degrees elbow angle (Figure A), she demonstrated nearly extended elbows with her hands at 12 o'clock on the handrim of the drive wheels. This limited her ability to produce an efficient and effective push stroke. The rear seat height of the hospital-issued chair was lowered to 16.5 inches for a 17-inch finished rear seat height. This was the lowest possible rear seat height for this chair, but it still did not provide optimal access

to the handrims using standard 24-inch rear wheels.

Leah was seen multiple times in the seating clinic during her acute rehabilitation stay. Interventions included further adjustments to the chair she was using and equipment trials to determine the optimal configuration and set up of a definitive wheelchair. The final configuration of Leah's definitive wheelchair required a rear seat height of 15.5 inches and a finished rear seat height of 17.5 inches with 26-inch rear wheels and a center of gravity preset of 2.25 inches. This setup allowed an elbow angle of 100 to 120 degrees with her hand at the top of the handrim (Figure B).

When you have been involved in wheelchair and seating prescription for more than 25 years, it is rare to encounter an individual who does not bring another similar person or situation to mind. However, Leah portrayed a unique clinical presentation I had never encountered before. I have worked with countless individuals with paraplegia, but none who, at 5 feet 5 inches, required a 15.5-inch rear seat height, 26-inch drive wheels and a 2.25-inch forward axle position to achieve an efficient push stroke. Additionally, the incomplete nature of her injury with a rapidly changing clinical presentation added to the challenge of configuring and setting up her chair for her current needs while planning for potential future adjustments.

Leah's buttock pain and difficulty with transfers on an air cell cushion prompted us to trial several seat cushion options. She clearly required a cushion with more stability to promote functional



FIGURE B

Leah in her definitive chair. Note the elbow angle, the low rear seat height and relatively large rear wheel.

independence with transfers. I had minimal concerns regarding tissue injury due to her intact sensation and ability to perform independent repositioning and weight shifts. Additionally, my clinical experience taught me that individuals with incomplete injuries and neurogenic pain akin to her "burning butt sensation" frequently have an increased sitting tolerance on firmer cushions. I have often seen these persons report improved comfort on what would be considered overly inflated air cell cushions. After multiple trials, a contoured viscoelastic foam seat cushion was determined to provide the most stable surface for transfers and provide Leah with the best sitting tolerance.

Also unusual for a person with a T12 incomplete injury, Leah's chair was configured with 3 inches of seat slope, often referred to as "dump" (Figure C). I had initial concerns that this aggressive seat slope would present a challenge for transfers. Still, I recognized that it also had the potential to benefit her in other ways. Given her need for a low rear seat height to maximize her access to the drive wheels for propulsion, this configuration would offer a higher front seat surface for transfers. Provided she could

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FIGURE C Seat slope
3° Difference Between Front and Rear Seat Height

scoot forward to the front of the seat, Leah would be at a more level transfer height with surfaces like her bed and car. The considerable seat slope also provided the opportunity to decrease her tendency toward anterior pelvic tilt and excessive lumbar lordosis. Increasing her hip flexion might assist in stabilizing her pelvis in a more neutral position and reduce the pull of her psoas muscles on her lumbar spine by placing them in a shortened (more relaxed) position. My experience has validated what my education taught me about spasticity being both velocity- and length-dependent. Clinically, sitting with greater degrees of knee flexion and ankle dorsiflexion can often help reduce the impact of extensor spasticity for some individuals. Fortunately, the stability of a viscoelastic seat cushion and improving strength and endurance helped Leah gain independence with transfers. Both her posture and her spasticity improved with the prescribed seat slope (Figure D).

Despite my years of experience, I find that the front frame configuration of a rigid frame wheelchair can be the most challenging to determine for a new user. The decisions regarding frame length, front frame bend, caster position and footrest taper impact not only the user's seated posture but also the weight distribution of the wheelchair and environmental access. Furthermore, unlike many other selections, these choices lack future adjustability. Adding to this challenge is the fact that new users are often rapidly changing in their abilities. They also have



FIGURE D Note Leah's frame length, frame angle, knee angle and foot placement

no experience regarding how they prefer their wheelchair to be set up for comfort or to allow them to do everything they want or need to do from their chair. Unfortunately, many are hoping not to need a wheelchair and are reluctant participants in the decision-making process.

Leah was anything but a reluctant participant in the process of obtaining a chair. However, her abilities were

rapidly changing, and her only frame of reference was an ill-fitting hospital chair. She was hopeful that her lower extremity strength would continue to improve and that she would progress to standing and walking in some capacity. Additionally, she and her inpatient physical therapist had discussed the possibility of a front wheel power add-on. This would provide her with improved independence with mobility in unpaved areas and uneven terrain surrounding her home. She wanted to ensure that her chair would be compatible with this type of device if she chose to pursue one later. After careful consideration, we decided that an 80-degree front frame angle and an additional inch of frame from the front edge of the sling to the front frame bend would best meet her needs (Figure E). This configuration supported sufficient knee flexion to help quiet her lower extremity spasticity. It also accommodated her muscular calves, avoiding contact with the front edge of the seat sling. Pairing this with a 2-inch "Y" style footrest taper ensured that an angle adjustable footplate could be replaced with a flip-back footplate, if needed, to permit sit-to-stand transitions. A flip-back footplate typically sits farther rearward than an angle adjustable footplate (Figure F). An 80-degree front frame angle ensured that if this change was made, she would have adequate foot support without requiring significantly more knee flexion.

A 14-inch-high back support with a gentle contour was chosen to provide both posterior pelvic and lumbar support while sitting below her scapulae. This height provided adequate posterior pelvic and trunk support and allowed Leah full shoulder range of motion for propulsion and functional activities. Angle and depth adjustable hardware and angle adjustable back canes

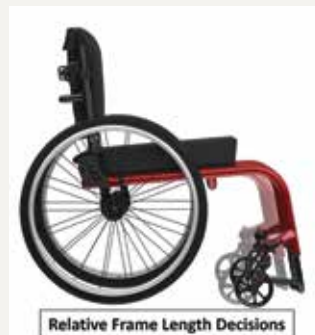


FIGURE E Frame length
Relative Frame Length Decisions

were selected. Having adjustment through both the canes and back support hardware provided the ability to fine-tune the backrest for postural control and to ensure that the desired seat depth was achieved and maintained.

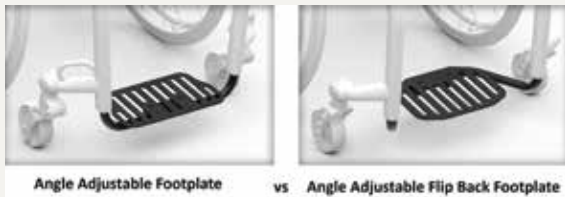


FIGURE F Footplate options

Quick-release hardware ensured that the back support could be removed for transport.

Minimal adjustments to the prescribed configuration of the chair were required when Leah was seen for the initial fitting of her definitive chair. These included back support height and angle, horizontal axle position and footplate angle adjustments.

Leah reported feeling “comfortable” in her chair with the recommended configuration and setup. She said that it felt “light and easy to push.” By the time she received the chair, Leah had progressed with her ability to perform higher-level wheelchair skills, including independence with wheelies. She had continued to experience the return of muscle strength below her level of injury but was not performing sit-to-stand transitions or ambulation outside of therapies. Her spasticity had also increased and continued at times to interfere with her transfer ability. She was contemplating a change in medical intervention to help decrease her



Leah holds a wheelie.

spasms. Still, she was hesitant because she recognized that she often used her spasticity to compensate for deficits in strength. Her continued changes in physical presentation



Leah, happy in her definitive chair

and abilities highlight the importance of planning for changes in the setup of a chair and for establishing follow-up visits based on an individual’s unique needs. With that in mind, and because she lives a significant distance from our clinic, we discussed having her schedule a follow-up to coincide with her next physician visit.

Sometimes when you encounter a patient with an unusual presentation it can be a bit daunting to know how to begin. Just as you should do with any user, proceed one step at a time: Gather a comprehensive picture of everything the user wants and needs to do from their chair. Determine the initial setup needed and ensure you have planned for anticipated changes. Implement an appropriate follow-up plan and schedule based on the individual’s situation. We did this with Leah, and I am confident we can continue to optimize the setup of her chair in the future.

I would like to extend a special thank you to Leah for allowing us to tell her story, and to Rich Blanchette, ATP with NuMotion Chicago, who was an integral member of Leah’s wheelchair and seating team.

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Deborah L. Pucci, PT, MPT, received her degree in 1998 from Northwestern University in Evanston, Illinois. She has 25-plus years of clinical experience in neurologic rehabilitation, with specializations in wheelchair seating and mobility and acute spinal cord injury. She has held multiple positions since 1999 at the Shirley Ryan AbilityLab. (formerly known as the Rehabilitation Institute of Chicago), including senior therapist on the acute spinal cord injury unit, research study coordinator for the spinal cord injury model systems program, and wheelchair and seating clinical specialist. She has presented continuing professional education courses and lectures domestically and internationally in the areas of seating and mobility and acute rehabilitation for spinal cord injury. Currently, Pucci works as a clinical educator for Ki Mobility and as a clinical specialist for the Shirley Ryan Ability Lab wheelchair and seating clinic.